Different Path Planning Approaches for Autonomous Robots

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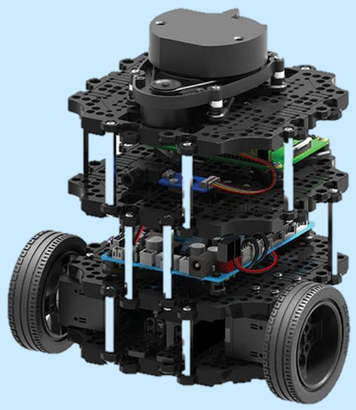
Abstract

Robotics is the future of technology. Statistically most of the industrial companies are in the process of installing robotics systems and technologies in different kinds of sectors. Moreover, nowadays robots without human intervention have come into highlight and have been in a high demand from not only autonomous vehicle industries but also from other different kinds of corporate industries. For that reasons, different kinds of path planning algorithms are needed for different kinds of requirements according to the industrial needs. So, finding the most efficient algorithm among the existing path planning algorithms and tuning the parameters to its maximum efficiency is going to be the key for meeting the requirements of the robot.



Turtlebot

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Motivation/Introduction

The future of Robotics and Autonomous system is solely dependent upon Navigation system. Thus path planning is one of the key elements for robotic developments.

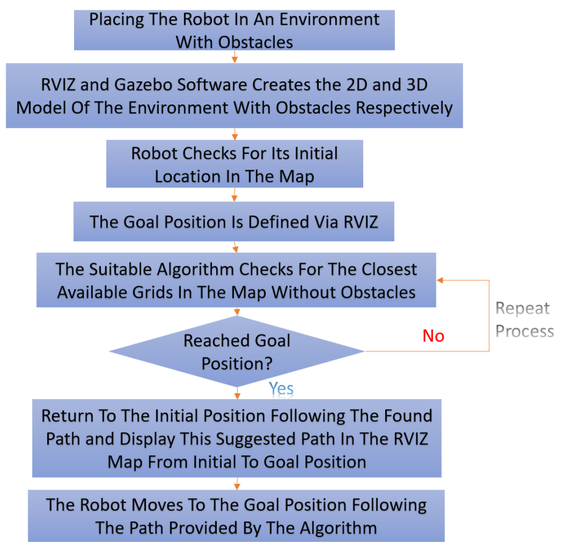
The usage of autonomous robots and vehicles has grown rapidly in the past few years. As per example different vehicle manufacturing companies (like Tesla, Tata etc.) have already introduced and launched their autonomous vehicle products in the market. Tesla has even launched their autopilot technology in their autonomous vehicles. Automated robots and UAV are also an upcoming emerging technology which are being industrialized very rapidly. For example, many restaurants in Japan have started using autonomous robots for serving foods to the customers. Autonomous moving robots are used for delivery services. The path planning is also used for autonomous underwater vehicles to complete their required tasks.

Movement of robots in an environment avoiding all kinds of obstacles to reach the final destination is a difficult task which is carried out by these algorithms via grid by grid calculations of the whole map of the environment.

Scope/Aim of the Paper

This paper is focused on describing three different kinds of basic path planning algorithms and applying them in simulated models to show the difference between the algorithms. Also, the possible improvements and constraints of the algorithms are discussed.

Flowchart



Methodology

Obstacle avoidance in a given map using the laser scanner values from the Turtle Bot which is used in the simulation.

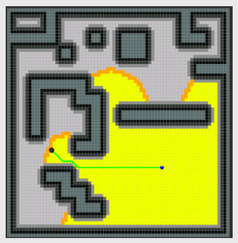
Using Dijkstra algorithm to find the shortest path from the initial position to the desired goal position for the Turtle Bot.

Modifying the Dijkstra path planning algorithm to polarize the direction of the search for the goal location. It is done by using heuristic approach to find the Euclidean or Manhattan distances and implementing Greedy Best First Search (BFS) Algorithm.

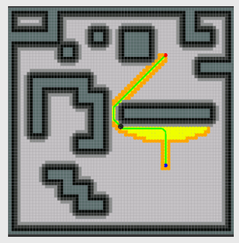
Combining both the Dijkstra and BFS algorithm to find the shortest ideal path for the Turtle Bot from the initial position to the goal location by applying A* search algorithm. The proposed path by this algorithm is search by polarized direction and avoid the longer route to reach the goal.

Summarize the three of the algorithms and implementing each in the same virtual environment using RVIZ and Gazebo simulation through ROS. Checking the difference between the pattern of the proposed path by each of the algorithms.

Pictorial Representation



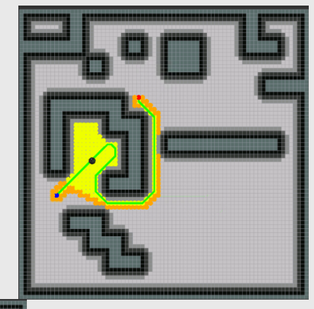
Dijkstra And BFS

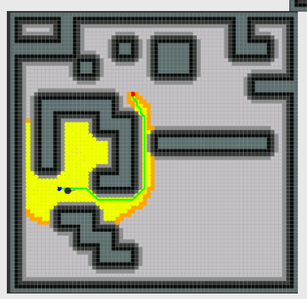


Different uses of Algorithms

Algorithms	Uses		
	Uses	*Achievable*	*Not achievable*
Dijkstra	This algorithm can be used to find the shortest path from the initial position to the goal location. It can traverse through any kind of environment but the speed will be pretty slow with the increase of the size of the environment.	Shortest path, Unpolarized grids Exploration	Less time, Less memory
Greedy BFS	This algorithm is used to explore the grids in a particular direction rather than 360 degrees. The applications of this algorithm is best suited for an environment with long horizontal and vertical obstacles.	Polarized grid exploration, Less time to reach the goal, Less storage requires as number of nodes are comparatively less, Uses heuristic distances to calculate the approximate distance to the goal	Shortest Path to the goal (In case of curved obstacles)
A* Search	The robot path planner can execute polarized grid exploration and reach the goal position using the most optimum path available in the map. Many autonomous robots moving in a plain area with static obstacles use this algorithm to move autonomously.	It can achieve all the cases in a static environment with the help of obstacle avoidance of the robot and provides the most efficient path.	Can't perform well in the dynamic environment with continuously moving obstacles.

Longer Path using BFS Algorithm





Optimized path using A* Search algorithm

Results and Discussions

Path planning is the most fundamental requirement of any autonomous robot or vehicles. As maximum of the robots in today's world are self-operative, their fundamental requirement is path planning algorithms. Many robots are used for different kinds of works and moves in different kinds of environments. Therefore, they are required to have path planning algorithms according to their executable works. Also, implementation of obstacle avoidance with these path planning algorithms helps them to perform more efficiently in any kind of maps.

CONCLUSIONS

Basically, these algorithms mentioned above are the basic of path planning algorithms. All the robots performing their tasks in a certain specified environment uses one of these algorithms as a base for their path planning process. The robots or autonomous vehicles moving in a dynamic environment uses the SLAM algorithm to get rid of the existing constraints of the generic path planning algorithms and move autonomously in unknown environments.

REFERENCES

Pablo Muñoz, María D. R-Moreno and David F. Barrero. "Unified framework for path-planning and task-planning for autonomous robots" in Robotics and Autonomous Systems Elsevier, 30 January 2015, Revised 4 April 2016, Accepted 22 April 2016, Available online 11 May 2016, Version of Record 6 June 2016.

Clment Petres; Yan Pailhas; Pedro Patron; Yvan Petillot; Jonathan Evans; David Lane, "Path Planning for Autonomous Underwater Vehicles" in IEEE Transactions on Robotics, April 2007.

N. Sariff and N. Buniyamin, "An Overview of Autonomous Mobile Robot Path Planning Algorithms," in 4th Student Conference on Research and Development (Scored 2006), June 2006

Christos Katrakazas, Mohammed Quddus, Weh-Hua Chen and Lipika Deka, " Real-time motion planning methods for autonomous on-road driving: State-of-the-art and future research directions" in Transportation Research Part C 60 (2015) 416-442

Buniyamin N., Wan Ngah W.A.J., Sariff N. and Mohamad Z.," A Simple Local Path Planning Algorithm for Autonomous Mobile Robots" in International Journal of Systems Applications, Engineering & Development, Issue 2, Volume 5, 2011

Adem Tuncer and Mehmet Yildirim, "Dynamic path planning of mobile robots with improved genetic algorithm", in Computers and Electrical Engineering 38 (2012) 1564-1572